<8mm by 0.39 (87.2% concordance). PLSR regression of the overall cohort identified median ST XSA and height as key predictors of graft diameter. The 95% prediction error for the overall model for a single future patient was 0.9mm. That is, predicted graft diameters of 8.92mm or above would have a 2.5% chance of being <8mm in theatre.

Discussion: The ability to predict graft diameter prior to surgery may improve surgical efficiency for ligament reconstruction, particularly if a minimum graft diameter threshold is to be achieved. Previous studies have correlated patient anthropometry and MRI XSA to intra-operative graft diameter, however this study is the first to present a validated predictive model. The results identify females receiving 4-STGT constructs at-risk of producing grafts <8mm, and this can be screened with MRI-based measurements of tendon geometry. More accurate predictive models that are easy to use provide surgeons with a useful clinical tool for surgical planning. With a future prospective study incorporating a range of intraoperative variables, this model can be further refined to increase its clinical applicability.

Conclusion: Patient height, gender and MRI cross-sectional measurements are significant predictors of graft diameter. Whilst the actual graft diameter required for each patient is a decision for the treating surgeon, this study confirms previous correlations, and proposes a novel method of stratifying and accurately predicting the likely graft diameter for each patient.

http://dx.doi.org/10.1016/j.asmart.2016.07.166

B0730

Anatomic considerations in arthroscopic reconstruction of the coraco-clavicular ligament in patients with acromio-clavicular joint dislocation

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Background: Arthroscopic reconstruction of the coraco-clavicular ligament has been described in some studies. Few published reports have considered the importance of anatomic reconstruction. The present study reports the importance of anatomic reconstruction and evaluates the position of the reconstructed ligaments and the clinical and radiographic results of arthroscopic reconstruction of coraco-clavicular ligament.

Material and Methods: Arthroscopic reconstruction of the coraco-clavicular ligament using a Fiber tape and Dog Bone Button (Arthrex) was performed in 8 shoulders between June 2014 and November 2015. The mean age was 39.9 years (range, 28 to 55 years). The mean follow-up period was 9.1 months (range, 4 to 20 months). The injuries were as follows: Rockwood type 3 (n=6), Rockwood type 4 (n=1), and Rockwood type 5 (n=1). We evaluated the position of the bone tunnel on CT images, and the extent of the tunnel widening and loss of reduction using radiography. The subjective patient outcomes were evaluated.

Results: The distance from the lateral side of the clavicle to the clavicular tunnel was 28.8 ± 5.2 mm. If we divided the sagittal view of clavicle into three columns (anterior, middle, posterior), 1 shoulder was anterior, 4 shoulders were middle, and 3 shoulders were posterior. The distance from the anterior aspect of the coracoid to the coracoid tunnel was 29.2 ± 5.3 mm. Intra-operative reduction was lost in 6 patients (75%). The clavicular tunnel width was 5.5 ± 1.0 mm. The coracoid tunnel width was 5.1 ± 0.9 mm. One patient reported experiencing slight pain. The subjective patient outcomes were excellent in 6 cases and good in 2 case.

Discussion: Although our clinical results were mostly satisfactory, we experienced tunnel widening and a loss of reduction. We hypothesize that the reason for this is that the position of the bone tunnel in these studies tended to differ from the anatomic attachment of the coraco-clavicular ligament; thus, we could not reconstruct the coraco-clavicular ligament in the anatomic position.

Conclusion: Arthroscopic reconstruction of the coraco-clavicular ligament is recommended in patients with acromio-clavicular joint dislocation. However, in order to decrease the enlargement of the bone tunnel and the loss of reduction, it was suggested that we should reconstruct the bone tunnel in the anatomic position.

http://dx.doi.org/10.1016/j.asmart.2016.07.167

B0743

Prognostic factors of retear after arthroscopic repair of massive rotator cuff tear

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Introduction: Retearing after arthroscopic repair of massive rotator cuff tear has been reported to range from 20% to 60%. This study aimed to evaluate the possible prognostic factors relating to retear of repaired massive tears of rotator cuff.

Materials and Methods: A total of 24 patients underwent arthroscopic repair of massive tears of rotator cuff during the period of 2009-2012, was assessed and reviewed, with clinical signs and functional assessment with UCLA and ASES score as the assessment criteria, as well as pre- and postoperative magnetic resonance image (MRI) assessment performed. The following factors were compared between the intact group versus retear group for final analysis: age of patient, smoking, diabetes mellitus (DM), history of significant trauma to the shoulder, presence of subscapularis tear, long head of the bicep tendon condition, delamination, size of tear, and presence of significant muscle atrophy (preoperative MRI).

Results: With a mean follow-up of 32 months among this 24 patients (mean age, 55 years), MRI revealed a complete retearing in 4 (17%) cases and partial retearing in another 4 (17%) cases. Patients with complete retear was significantly older than the group without tear. None of the patient with a history of trauma got retear or partial retear. The retearing rate of patients with either DM, LHB tear requiring tenotomy, or subscapularis tear requiring repair were significantly higher than those without them.

Discussion and Conclusion: Older age, DM, presence of LHB tear requiring tenotomy or subscapularis tear requiring repair are relative poor prognostic factors for retearing of repaired massive rotator cuff tear.

http://dx.doi.org/10.1016/j.asmart.2016.07.168

B0746

Altered three-dimensional knee kinematics during step and turn are associated with patient-reported outcomes following multiple-ligament knee reconstruction

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Background: Multiple-ligament knee injury is devastating to patient function and a challenge for the orthopaedic surgeon. Considering the important role the biomechanics of the knee may have for overall patient function and its known contribution to long-term joint degeneration, detailed knowledge of knee function following multiple-ligament reconstruction (MLKR) could provide an important adjunct to post-operative rehabilitation and management. However, the biomechanical function of MLKR knees remains largely unknown. Previous work by our group has identified altered knee kinematics in MLKR patients compared to healthy controls during level walking, although the ability of patients to negotiate a more challenging task, such as step descent with a turning movement, is yet to be examined. To address this gap in the current knowledge, the purpose of this study was to i) determine differences in knee kinematics during a step and turn task between MLKR knees and matched healthy controls and ii) establish the relationship between knee kinematics and IKDC score in patients that have undergone MLKR.

Materials & Methods: Gait analysis was performed on 21 patients that had undergone MLKR a minimum of 12months prior. A second group of healthy participants ($N = 17$) was matched for gender, as well as within $\pm 10\%$ of height, weight and age. Retroreflective markers were attached to anatomical landmarks of the feet, lower limbs and pelvis (Cleveland Clinic marker set), supplemented by marker clusters attached to the middle of the thighs and calves. Following familiarisation trials, volunteers were recorded with a high-speed optoelectronic camera system (200Hz, Motion Analysis Corp, USA) while descending from stairs onto the floor, leading with the reconstructed limb and stepping over the lead foot with the contralateral limb to land at 90° to the original direction of travel. Volunteers were instructed to land with their lead foot placed parallel to the direction of travel prior to contralateral toe-off from the step. Three-dimensional knee angles and foot progression angle at initial foot contact, as well as range of motion during weight acceptance from initial contact to contralateral foot contact were extracted from each of 10-12 trials. Patients were compared to their matched control using a single-case approach with unpaired Student t-tests, while partial least squares regression was used to associate knee kinematics with IKDC and KOOS scores within the MLKR group.

Results: A sample of 13 males and 8 females were recruited, with an average period from surgery to follow-up of 5.4yrs (IQR 2.2 − 9.8). The control group was successfully pair-matched, with no significant differences between MLKR and control groups for age at follow-up, height, weight or BMI. Injury patterns were also variable between patients, with an incidence of 12.5% and 6% for nerve injury and vascular injury respectively, as well as meniscal repair or meniscectomy (25%). In addition, more than half the sample suffered other injuries, including fractures of the lower limbs and pelvis.

The MLKR group exhibited significantly ($p=0.001$) increased external rotation and significantly ($p=0.031$) increased flexion of the knee at initial foot contact. During weight acceptance, MLKR patients displayed significantly ($p=0.019$) increased internal rotation, although no significant difference in knee range of motion in any plane were observed during the entire pivoting movement. When compared on a single-case basis, 65% of patients landed with significantly greater knee flexion ($P < 0.05$), increased varus (47%) or valgus (47%), or increased external tibial rotation (82%) at initial ground contact. Similar patterns were observed for knee range of motion during weight acceptance, with MLKR patients displaying significantly reduced flexion (59%), frontal motion (47%) and increased internal rotation (59%). Regression analysis revealed that step and turn kinematics (frontal angle at initial contact and frontal range of motion during weight acceptance) were significantly associated with IKDC score ($R^2_{pred} = 0.83$, $P<0.01$) in the MLKR group. The amount of valgus at initial foot contact was positively associated with improved scores, with patients landing with a varus knee returning poorer scores.

Discussion: The functional mechanics of the knee following MLKR remain largely unknown. The current study presents the first detailed insight into the knee kinematics during a strenuous task such as a step descent and turn. The results suggest that MLKR patients employ different knee kinematics during step descent to prepare for a pivoting action. Although MLKR patients landed with a more toe-out pattern compared to healthy controls, which may have explained differences in knee rotation, MLKR patients also displayed differences in frontal angle at initial contact and frontal range of motion during weight acceptance. The degree of knee valgus at initial contact was positively associated with IKDC and KOOS scores; however the mechanisms explaining this relationship remain unclear. These results suggest that frontal alignment over the short-medium term is important to patient-reported outcomes of MLKR. Future work will focus on understanding the pre-operative and peri-operative factors that determine knee functional patterns and outcome during ongoing management.

Conclusion: MLKR patients utilise a distinctly abnormal pattern of knee kinematics to perform a step descent and turn task which is associated with self-reported outcomes. These results highlight the importance of knee function during post-operative rehabilitation and as a marker of recovery throughout ongoing management of the condition.

http://dx.doi.org/10.1016/j.asmart.2016.07.169

B0747

Effects of remnant tissue preservation on tunnel enlargement after anatomic double-bundle anterior cruciate ligament reconstruction

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Background: Bone tunnel enlargement is a problem that has been observed after reconstruction of anterior cruciate ligament (ACL) [Höher 1998, Robert 2004, Wilson 2004]. Tunnel enlargement and coalition could cause problems during revision surgery and necessitate staged procedures [Järvelä 2008, Siebold 2007]. Recently, preservation of the ACL remnant tissue has been expected to have several potential advantages, such as preservation of proprioceptive cells [Adachi 2002, Lee 2008] stability preservation [Kondo 2015, Muneta 2013] and graft revascularization and ligamentization [Ahn 2010, Gohil 2007]. In addition, remnant preservation may inhibit tibial tunnel enlargement in a single-bundle ACL reconstruction [Demirağ 2012, Zhang 2014]. However, the effect of remnant tissue preservation on tunnel enlargement in anatomic double-bundle (DB) ACL reconstruction has not yet been established. We hypothesized that the incidence and the degree of tunnel enlargement of remnant-preserving procedures will be significantly less than that of remnant-resecting procedures after anatomic double-bundle ACL reconstruction. In addition, the incidence of tunnel coalition in remnant-preserving procedures will be less than in remnant-resecting procedures. The purpose of this study was to test these hypotheses.

Material and Method: A prospective study was conducted between 2009 and 2013 using patients who had an isolated ACL injury in the unilateral knee. A total of 80 patients underwent anatomic DB ACL reconstruction using hamstring tendon autografts. Based on the Crain classification of ACL remnant tissue [Crain 2005], 40 patients underwent the remnant-preserving procedure (group P) [Yasuda 2012] and the remaining 40 patients underwent the remnant-resecting procedure (group R) [Yasuda 2004]. After surgery, patients underwent the same rehabilitation. All patients were informed that they would undergo a 2-dimensional (2D) and 3 dimensional (3D) CT at 2 weeks and 1 year after surgery. Then the images were processed by using a work station (ZioTerm 2009, Ziosoft, Tokyo). The oblique axial (OA), sagittal (OS), and coronal (OC) views were reconstructed based on the direction of the longitudinal axis of the femoral and tibial tunnels from CT data using multi-planar reconstruction. The tunnel measurement was taken at 10 mm from the intra-articular outlet of the femoral and tibial tunnels in OA, OC, and OS views, respectively. The tunnel area measurement was taken digitally at the same level of both the femoral and the tibial tunnels in OA views using ImageJ software (ver. 1.48, National Institutes of Health). The percentage change in the diameter and area between the images at 2 weeks and 1 year was defined as the degree of tunnel enlargement. The incidence of tunnel enlargement was determined by the number of femoral or tibial tunnels that tunnel area enlarged more than 30%. The position of the femoral and tibial tunnel was evaluated by observing the AM and PL tunnel outlets on the intra-articular bone surface of 3D CT images using the Quadrant method [Bernard 1997]. Tunnel coalition was determined by observing the AM and PL tunnel outlets on the intra-articular bone surface and 10 mm from the intra-articular outlet of the femur or the tibia using OA, OC, and OS views, and measuring the width of the bony septum between the 2 tunnels [Hantes 2010]. When the width was zero, we defined it as 'tunnel coalition'. Intra-observer variability for tunnel measurement was satisfactory (mean intraclass correlation coefficient, 0.84; range, 0.81 to 0.92). A priori power analysis was performed. A sample size was calculated to have 74−85% power to test the hypothesis.

Results: (1) There were no significant differences in the femoral and tibial tunnel positions between the groups. (2) Concerning the femoral AM tunnel, the degree of tunnel enlargement in OC and OA views in group P was significantly less than those of group R. Concerning the femoral AM tunnel area, the degree of tunnel enlargement in group P was significantly less than those of group R. The incidence of femoral AM tunnel enlargement was significantly less in the group P than in the group R (3) Regarding the tibial tunnel enlargement, there were no significant differences between the groups. (4) There were also no significant differences in the tunnel coalition between the groups. (5) Regarding knee laxity, we divided the patients' side-to-side laxity values into 2 categories, $\leq$ 2mm and $>$ 2mm; the chi-square test showed that anterior laxity in group P was significantly better than in group R. Postoperative the Lysholm knee score, IKDC evaluation, and mean isokinetic peak torque of the quadriceps and hamstring muscles, there were no significant differences between the 2 groups.

Discussion: The degree of femoral AM tunnel enlargement of group P were significantly less than those of group R. The incidence of femoral AM tunnel enlargement was significantly less in group P than in group R. Then regarding the patients' side-to-side laxity values, anterior laxity in group P was significantly better than in group R. Preservation of the ACL remnant tissue in ACL reconstruction is expected to have several potential effects to improve the clinical results. Some study reported that remnant tissue preservation resist bone tunnel enlargement, because of remnant tissue may restrict synovial fluid propagation within the tunnel [Berg 2001]. And previous studies showed preservation of the ACL remnant tissue improve knee stability [Wu 2013, Kondo 2015]. We consider that preservation of the ACL remnant tissue inhibit tunnel enlargement because of prevent biological factors such as proinflammatory cytokines of synovial fluid and biomechanical factors such as micromotion at the tunnel by graft.

Conclusion: The degree of tunnel diameter and area enlargement of remnant-preserving procedure are significantly less than those of the remnant-resecting procedure in the femoral AM tunnel. These results indicated that remnant-preserving anatomic double-bundle procedure may have potential to inhibit incidence of the tunnel enlargement.

http://dx.doi.org/10.1016/j.asmart.2016.07.170

B0754

Long head of biceps tenotomy and tenodesis don't affect elbow flexion and forearm supination strength

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Background: Lesions of long head of biceps tendon (LHBT) are often seen in patients with rotator cuff tears, for which tenotomy and tenodesis of the LHBT are frequently performed. Although the good clinical results of tenotomy and tenodesis in simultaneous arthroscopic rotator cuff repair (ARCR) were reported, weakness of elbow flexion and forearm supination strength are also predictable. The purpose of this study is to compare the postoperative outcome and the muscle strength of elbow flexion and forearm supination after ARCR between cases with LHBT tenotomy, tenodesis and preserved.

Material: Sixty-one patients who underwent ARCR with a minimum 1 year of follow-up are included in this study (mean age 64.6 $\pm$ 10.6; 27 women and 34 men). We checked contralateral shoulders of these patients with MRI or ultrasonography and the patients who had rotator cuff tear or underwent previous ARCR in the opposite shoulders were excluded. Cases who had re-rupture of repaired rotator cuff were also excluded. For all supra- and/or infraspinatus tendon tears we performed ARCR using suture-bridge technique, and if the subscapularis tendon lesions were included, the tendon repair was also performed by simple suture or suture-bridge ARCR. When the LHBT lesions such as subluxation or dislocation, partial tear more than half of it or hourglass deformity were identified during the operation, we performed LHBT tenotomy or tenodesis procedures. We added tenodesis for cases who were under 65 years old or had high activities in life even if they were over 65 years old (tenodesis group; 8 cases). For the other cases with LHBT lesions we performed LHB tenotomy (tenotomy group; 15 patients) and for the other cases who had no LHBT lesions we preserved LHBT (control group; 39 patients). The tenodesis procedure was performed in 45 degrees of elbow flexion and forearm neutral position, LHBT was pulled proximally with manual max strength and was immobilized using a tenodesis anchor (PEEK SwiveLock Tenodesis®, Arthrex, Japan) on the bicipital groove at the suprapectoral position. Tenotomy was performed by resecting the intraarticular lesion of the LHBT. After these procedure, the rotator cuff repair was performed. The almost same shoulder rehabilitation protocols were performed for each group but we prohibited the elbow motion for three weeks to the patient with the tenotomy and the tenodesis group. We measured the quantitative muscle strength of elbow flexion and forearm supination pre- and postoperatively. Strength index which were defined as ratio of affected side divided by contralateral side were compared statistically among these groups. For clinical evaluation we used the Japanese Orthopaedic Association (JOA) score which was also compared among these groups. We used one-way ANOVA and Scheffe's method for the statistically evaluations. A p value of $<$.05 was defined as statistically significance.

Results: The average age in each group was 71.6 $\pm$ 4.94 in the tenotomy group, 65.5 $\pm$ 5.78 in the tenodesis group and 61.9 $\pm$ 11.9 in the control group, respectively. The age of the tenotomy group was significantly higher than the control group ($p = 0.012$). The mean muscle strength of elbow flexion in each group was 165 $\pm$ 34.7 N in the tenodesis group, 113 $\pm$ 34.4 N in the tenotomy group and 157 $\pm$ 48.5 N in the control group, respectively. The mean muscle strength of forearm supination in each group was 47.4 $\pm$ 12.1 N in the tenodesis group, 35.6 $\pm$ 14.1 N in the tenotomy group and 45.9 $\pm$ 13.4 N in the control group, respectively. The muscle strength index of elbow flexion in each group was 0.89 $\pm$ 0.17 in the tenodesis group, 0.92 $\pm$ 0.25 in the tenotomy group, and 1.00 $\pm$ 0.16 in the control group. The muscle strength index of forearm supination in each group was 0.77 $\pm$ 0.09 in the tenodesis group, 0.80 $\pm$ 0.17 in the tenotomy group, and 0.90 $\pm$ 0.23 in the control group. There were no significant differences of muscle strength index of elbow flexion and forearm supination among these groups (elbow flexion; $p = 0.264$, forearm supination; $p = 0.313$). JOA score was 92.6 $\pm$ 6.0 points in the tenodesis group, 86.1 $\pm$ 14.8 points in tenotomy group, and 95.4 $\pm$ 6.3 points in the control group. The JOA score of the tenotomy group was significantly lower than that of control group ($p = 0.007$). In detail there was no differences of the pain score among these groups but the function and range of motion scores of tenotomy group were significantly lower than those of control group (pain; $p = 0.304$, function; $p = 0.021$, range of motion; $p = 0.003$).

Discussion: the tenotomy group was significantly older than the control group because we performed tenotomy for the over 65 years old cases. And the reason may be that rotator cuff tears of younger patients didn't have so severe LHBT lesions and consequently they didn't need the LHBT procedures. There were no significant differences about the strength index of elbow flexion and forearm supination among these groups. In the tenotomy group, it is possible the stump of biceps tendon may adhere somewhere and functioned. We made 3 weeks' prohibition of elbow flexion after LHB procedure so this situation may occur in our study. We must also consider the other elbow flexion muscle such as short head of biceps tendon, brachialis and